

IMPLICATIONS OF QUANTUM LOGIC TO THE NOTION OF TRANSCENDENCE

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ABSTRACT: This article attempts to study the notion of Transcendence from the perspective of Quantum Mechanics. The Laws of Physics reveal that nature is dynamic and it is understood in terms of mathematical models and relations. Uncertainty is a fundamental feature of the Quantum reality. Quantum structural pattern is the fundamental nature of reality, whether observable or unobservable. Transcendence in Quantum Mechanics is a dynamic concept which must be understood in terms of dynamic state. Transcendence in Quantum Mechanics is the process of uncovering deep treasures of the reality, which is dynamic. A movement toward the deeper reality of God is what is behind the notion of transcendence.

KEY WORDS: Boolean Logic, hidden variables, Fuzzy Logic, Hilbert Space, quantum mechanics, transcendence.

Implicaciones de la lógica cuántica para la noción de Transcendencia

RESUMEN: Este artículo intenta estudiar la noción de Transcendencia desde la perspectiva de la mecánica cuántica. Las leyes de la física revelan que la naturaleza es dinámica y es comprendida en términos de modelos matemáticos y relaciones. La incertidumbre es una propiedad fundamental de la realidad cuántica. El patrón cuántico estructural es la naturaleza fundamental de la realidad, bien sea observable o no observable. La Transcendencia en la Mecánica Cuántica es un concepto dinámico que debe ser comprendido en términos de un estado dinámico. La transcendencia en la mecánica cuántica es el proceso de descubrimiento de tesoros profundos de una realidad que es dinámica. Por ello, un movimiento hacia la realidad más profunda de Dios se halla tras la noción de Transcendencia.

PALABRAS CLAVE: Algebra de Boole, variables ocultas, lógica difusa, espacio de Hilbert, mecánica cuántica, transcendencia.

1. INTRODUCTION

Reality from the beginning has been understood in terms of mathematical models and relations. Mathematical models and relations have been very instrumental in exploring not only the physical reality but also the reality that lie beyond our reach. Pythagoras was the first to establish a link between the mathematical models and the physical reality. For a number of decades classical theory under the supremacy of Isaac Newton was the mathematical model for understanding the physical reality. Thought classical theory is so successful in describing the macroscopic world, some observations in the microscopic world cannot be described with mathematical models that were developed under Isaac Newton and his followers.

Observations in the microscopic world revealed that the way matter behaves in interaction with light has many different aspects which require new mathematical models of understanding reality. One characteristic that we see in the microscopic world, unlike in the macroscopic world, is that its mathematical models involve probability. Therefore, the understanding of these probabilities at the microscopic

world is the key and essential element to the solution of any conceptual problems of quantum mechanics.

The success of mathematical models in exploring reality and in solving conceptual problems of quantum mechanics is a clear indication that logic has its source in the laws of nature. Since logic has its source in the laws of nature and the mathematical models of quantum theory involves probability, the logic of things cannot be dissociated from the existence of probabilities. The existence of probability in nature modifies the way we understand some physical concepts such as position and momentum. The meaning of the quantum probability and its implications to quantum measurements have become the two main disputable issues since the beginning of quantum theory. In this work we are going to use the hidden variables, not only as a way of understanding the probabilities in quantum mechanics, but also as a way of solving conceptual problems in quantum mechanics.

The foundations of classical mathematical models are in Boolean logical relations. Boolean logical relations are based on the distributive law of logic and depend on the Aristotelian law of excluded middle. The axioms of Boolean logic were formalized by George Boole and Frege. Due to the probabilistic nature of its mathematical models, quantum theory cannot be fully understood from Boolean logical relations. Quantum logic is non Boolean; it allows the middle terms which are superposition of the binary sets. Therefore the degree of truth of a statement in quantum logic is not constrained to the binary truth values (true 1, false 0) but can range (inclusively) between «true 1» and «false 0». It can be any number that is superposition of «ture 1» and «false 0». The middle term in quantum theory becomes a powerful concept in solving any conceptual problem of quantum mechanics. It is due to this middle term that quantum logic, not only allows the gradual and inclusive transition between the binary sets, but also, it takes into account the different perspectives of the dynamic concepts.

2. QUANTUM PROBABILITY AND HIDDEN VARIABLES

Probabilities are not peculiar to quantum theory but they also arise in classical physics. Classical probabilities have their origin in ignorance of some of the details of what is going on (Polkinghorne. 40). Albert Einstein called this ignorance of the details as «hidden variables». However, John Von Neumann, the celebrated mathematician, proved that properties of quantum probabilities could never be taken as the consequence of ignorance of hidden variables. Later works by some theoretical physicists have proved that Von Neumann proof had an error. David Bohm for example, criticized Von Neumann and showed that quantum theory is possible in which probabilities arise from ignorance of details as we shall see later.

2.1. *Hidden Variable Theory*

The hidden variables were first suggested by Einstein and his followers in the paper known as EPR paper. The occurrence of probabilities in nature and

non – locality which are two fundamental features of quantum mechanics made Einstein and his followers, Podolysk and Rosen, so uncomfortable with the quantum theory that together they came up with a paper which attempted to defend determinism through testing the compatibility between non-local quantum entanglement and the special theory of relativity. This famous paper known as EPR paper (after Einstein, Podolysk and Rosen) was the heart of the famous debate between Einstein – Bohr.

In EPR paper, Einstein suggested the existence of some '*hidden variables*' in quantum mechanics, which if we knew them, would enable us to predict the outcome of his thought experiment with certainty (Hey - Walters.166). According to the conclusion of EPR paper, quantum theory gave only *partial description* of reality and there were some '*elements of reality*' that the theory ignores. The wave function, Einstein argues, «must be taken as representing, not the entire physical state of a system, but only our partial knowledge of that state» (Sklar. 217). Deep down the arguments of Einstein, there was a belief that physical theories must be deterministic in order to be complete. Bohr's interpretation of quantum theory was quite different from Einstein's and his followers. For Bohr the wave function provides the complete underlying description of basic states of nature and their dynamic evolution. Therefore quantum mechanics was complete and gives complete description of reality.

John Bell used the EPR arguments and the modified thought experiment to derive equations which settled the EPR Bohr – Einstein debate in favor of Bohr. Through his famous inequality¹, Bell proved that atoms and their kin can communicate instantaneously in total violation of the speed of light barrier. This instantaneous communication in quantum theory is known as *non – locality*. Moreover, contrary to Einstein, Bell proved that *local deterministic hidden variables* are impossible.

From the EPR debate we come to realize that the *non-locality* and *probability* are the objective features of reality. Non – locality is the instantaneous communication of particles that have become «entangled». And the essential feature for non – locality is the superposition. Probability exists due to uncertainty characteristics of the quantum reality. Without uncertainties there is no role for probability.

Superposition and uncertainty being the fundamental features of the microscopic world, they become important tools not only in developing a model which is relevant to quantum reality, but also in solving conceptual problems related to quantum theory. In situations where uncertainty is in the nature of things, like in quantum reality, the mathematical concept of fuzzy subset² is not

¹ The British physicist John S. Bell (1928-90) showed in 1964 that quantum mechanics predicts a violation of the inequalities, which are consequences of local hidden variables theories. Experiments are in agreement with quantum mechanics rather than local hidden variables theories by violating Bell's inequalities, in accordance with Bell's theorem.

² Fuzzy logic (in this work synonymous to quantum logic) is developed out of fuzzy subsets. It is a form of logic that allows for degrees of imprecision. Classical logic deals with

only useful but also it is an ideal tool for bridging the gap between the mathematical formulation and the impressions of the physical world. Uncertainty may be considered in specifications of variables and their values, in configurations, and also at the conceptual level.

A state of a particle may be classical (macroscopic) or quantum (microscopic). A classical state applies to the deterministic local realistic situations. In this state the probability function p is restricted to truth values «false 0» and «true 1». This means that a complete state of the physical world assigns only probabilities «false 0» or «true 1» to the outcomes of the experimental tests performed on the systems of interest. However, in the quantum state³ whereby the statistical predictions can be presented as the superposition of states, the probability function is allowed to be stochastic, in the sense that complete state can assign other probabilities between 0 and 1 to the possible outcomes. Therefore, the quantum state does not present us just with the outcomes of the various experimental possibilities with the individual probabilities but it presents us with the complete knowledge of the reality which enables the maximal set of probabilistic predictions of any possible future observations. The quantum state gives us knowledge of the situation by the quantum state complex amplitudes. In this case the hidden variables will not be considered in terms of pair $\{0,1\}$ but the truth value into which M maps S depends upon the context C .

2.2. Bohm's Hidden Variable Theory

Bohm's famous theory on hidden variables was proposed in 1952 as an alternative to the standard Copenhagen interpretation⁴. The basic formalism of Bohm's interpretation corresponds to Louis de Broglie's Pilot wave theory and builds on the insights of Bell. Bell's theorem demonstrated that there is no locally deterministic hidden variable theory that is compatible with quantum mechanics. Building on Bell's theorem, Bohm proved that no local hidden variable theory reproducing the statistical predictions of Quantum Mechanics is possible. As an alternative, he proposed the existence of *non-local hidden variables*⁵ (Bub).

two truth values: 'true' and 'false'. Fuzzy logics are multi-valued dealing with such concepts as 'fairly true' and 'more or less true'. These can be represented by numbers within a range $[0,1]$, with the number representing the degree of truth.

³ In quantum physics, a quantum state is a mathematical object that fully describes a quantum system. In a more general mathematical context, quantum states can be understood as positive normalized linear functional on a C^* algebra.

⁴ The standard interpretation of quantum mechanics associated with the ideas of Niels Bohr, who worked at the University of Copenhagen. In this interpretation as system (e.g. particle) can be described by a wave function, which is a complex function. The square of the wave function provides the physical significance which is the probability of a particular definite state. Therefore any prediction of the state of a system can only be probabilistic.

⁵ Non local hidden-variables theory is a theory in which hidden parameters can affect parts of the system in arbitrarily distant regions simultaneously. A hidden-variables theory that does not satisfy this definition is called a local hidden-variables theory. The only type of hidden-variables theories that appear not to have been ruled out are non local hidden-variables theories.

Bohm's interpretation is deterministic, non local and non relativistic. It is *deterministic* because according to Bohm, a system of particles is described in part by its wave function, evolving deterministically according to Schrodinger's equation. This description is completed by the specification of the actual positions of the particles. When a particle is sent into a two-slit apparatus for example, the slit through which it passes and where it arrives on the photographic plate are completely determined by its initial position and wave function. It is *non-local* because using Bell's results, Bohm postulated the existence of a non-local universal wave function that allows distant particles to interact with each other instantaneously. It is *non-relativistic* because it is able to account for all phenomenon of non-relativistic quantum mechanics⁶ such as spectral lines, scattering theory, superconductivity, the quantum hall effect and quantum computing.

Due to its deterministic, non local and non relativistic characteristics, Bohm's interpretation not only gives a more realistic approach to quantum mechanical calculations, but also it is capable of being extended beyond the domain of the current theories in a number of ways.

In the Bohm interpretation, every particle has a precise position and a precise momentum at all times, but we do not usually know what they are, though we do have limited information about them. These precise values are unknowable; they are «hidden variables» (Shimony. 262).

In Bohm's view, instead of the independent variables (r, t) of the wave function $\psi(r, t)$, one has an extra independent variable Λ , so that $\psi(r, t, \Lambda) \rightarrow \psi(r, \Lambda(t))$, where $\Lambda(t)$ are hidden variables that trace a trajectory of the particle of matter, deterministically. In this case the wave equation becomes more complicated than the Schrodinger wave equation. For n - body system, the wave function for a given particle becomes $\psi(r, \Lambda_1(t), \Lambda_2(t), \dots \dots \dots \Lambda_n(t))$, where r is the location of the single particle. Thus the wave function for a particle, say an electron, depends on the trajectories of all of the other particles of the system (Sachs. 66) The uncertainty principle limits us on what we can know about the particle but does not limit the properties of particles. Thus according to Bohm, the uncertainty principle is epistemic rather than ontic (Shimon. 262).

Epistemic interpretation of quantum mechanics which was proposed by Bohm, seems to be supported by a number of physicists. According to Bohr's epistemic interpretation, quantum mechanics does not describe nature as it is but *what we can say about nature* (Shimon. 185). Quantum state for example does not describe the actual knowledge of the particle but the available or possible knowledge. This includes the probabilities of all the possible results of all possible measurements. The inaccessibility to the actual knowledge of the particle is due to the limits imposed by the uncertainty principle.

⁶ In non relativistic quantum theory, particles are assumed to be neither created nor destroyed, to move slowly relative to the speed of light, and to have a mass that does not change with velocity. These assumptions apply to atomic and molecular phenomena and to some aspects of nuclear physics. Relativistic quantum theory applies to particles that travel at or near the speed of light.

3. LOGICAL LAWS OF PHYSICS

In general, our access to the knowledge of the physical world is only possible in mathematical terms. Mathematical formulations do not pay attention to the objects themselves but only to the system of relations and operations embodied in them. By paying attention to structural patterns rather than to particularities of contents, mathematical physics has been able to find affinities and even identities where common sense could only see disparity (Torreti. 5).

Mathematics as a means of accessing knowledge makes use of logical models in which the fundamental notion is that of *set, a collection of objects*. The fundamental notion of set being an abstraction does not appear to pay attention, in any essential way, with the specific structure of the physical universe (Penrose. 64). Therefore, the concept of *set*, may be used as a step forward of bridging the precisions of mathematical formulations and the wide-ranging impressions of the real world.

3.1. Classical Boolean Logic

Classical mechanics is an account of how physical systems move and change and therefore, it is only applicable to some aspects of the motion of a real physical system. The classical state is specified by assigning values to a certain set of dynamic variables which are the generalized position and momentum variables. The letters P and Q are usually used to refer to these generalized variables of momentum and position respectively. All other dynamical variables are represented as functions of these generalized variables and so their values are determined by the state. Hamilton's equations describe how the state changes in phase-space which leads to the dynamical properties of the particle to change over time.

Though every subset of phase space corresponds to a property of the system, *classical mechanics excludes certain subsets, such as the set of rational numbers for the value of energy E* (Bub). Therefore in classical mechanics the subset representing dynamical properties are restricted to the Boolean subsets of phase space. Boolean algebra is a non-empty set with two binary operations and a unary operation, defined on it such that in each subset A of phase-space x is associated with a characteristics function μ_A defined by: $\mu_A(x) = 1$, if $x \in A$ and $\mu_A(x) = 0$, if $x \notin A$ where x is a variable ranging over the elements (points) of phase-space. Therefore the null property, 0 represents the empty set which the particle *never has* and the universal property 1 represents the whole phase-space which the property *always has*. In Boolean binary algebra the element *belong* or *does not belong* to a set. The characteristic function takes only the values of «true 1» or «false 0».

Boolean subsets are generated by the open, closed, or half-open interval of values under union, intersection and complement and fit in with the properties of a classical mechanical system.

3.1. Quantum Non Boolean Logic

Quantum mechanics is derived as a generalization of classical mechanics in which commutation relations are imposed on the dynamical variables (Bub. 22). For example, for the position Q and momentum P of a particle moving along a line, $QP - PQ = ih$ where $h = \frac{h}{2\pi}$ and h is Planck's constant. Here we obtain a *non commutative algebra of dynamic variables which are associated with non - Boolean algebra properties*. Therefore the contexts for the foundations of quantum mechanics are non commutative logic and non - Boolean in their properties⁷. The properties of this algebra are represented as the operator algebra in a Hilbert space, a linear space over the complex numbers.

According to Jeffrey Bub, the transition from classical mechanics to relativistic mechanics involves the discovery that geometry is dynamical, so the transition from classical mechanics to quantum mechanics involves the discovery that possibility is dynamical: the possibility structure of our universe is not a fixed, Boolean structure, as we supposed classically, but is in fact a non-Boolean structure that changes dynamically (Bub).

Quantum logic is a non Boolean structure which is built on the theory of fuzzy subsets. Fuzzy subset has the characteristic function which may take any value in the interval $[0,1]$. Due to the range of values in fuzzy theory we speak of fuzzy subsets rather than fuzzy sets. An element x_i of E in fuzzy subset may be a member of $A(\mu_A = 0)$, it could be a member of $A(\mu_A \text{ near } 0)$, it may be more or less member of $A(\mu_A \text{ neither too near } 0 \text{ nor too near } 1)$, it could be strongly a member of $A(\mu_A \text{ near } 1)$, or finally it might be a member of $A(\mu_A = 1)$.

The notion of membership in fuzzy subsets takes on an interesting range which is spread out. Fuzzy subsets may contain a little more of one membership than the other and vice versa. In this way it allows us to construct a mathematical structure in which one may be able to study the imprecise concepts that are related to dynamic variables which are often poorly defined. The poor definition of these concepts is due to fact that their memberships in a subset are somewhat wide-ranging and inclusive contrary to membership of Boolean sets which are mutually exclusive.

From the above discussions we observe that a quantum system, unlike classical systems is full of components and therefore the same reality may be described in many different ways. The many possible ways of speaking of the same reality, all mutually exclusive has lead to internal contradictions or paradoxes. The

⁷ In ordinary Boolean subsets if $M = [0,1]$, $A \cap B = A \cdot B$ and $A \cup B = A + B$. The operators (\cdot) and $(+)$ in Boolean binary algebra are called Boolean product and Boolean sum respectively. These operators correspond to logical OR and AND. In fuzzy subsets where $M \neq \{0,1\}$, except in few trivial cases the above operators do not give the same results. Though most properties of an ordinary power set are found again in a power set of fuzzy subsets, the properties of ordinary power set $A \cap \bar{A} = \emptyset$ and $A \cup \bar{A} = E$, do not hold in fuzzy subsets as they hold in Boolean logic. In fuzzy logic $A \cap \bar{A} \neq \emptyset$ and $A \cup \bar{A} \neq E$.

presence of many components is due to the fact that the quantum state with its intrinsic spread-outness of classical quantities represented by the spread-outness of the probability distributions associated with those values representing the description of the actual state of the particle (Sklar. 178). For instance, in the nuclear experiment, if a silicon crystal diffracts a neutron we should, according to Bohr, speak of the neutron as a wave, while its detection by a counter would force us to construe it as a particle (Omnes. 181). Depending on our choice of the experimental setting we have two different logics that cannot be embedded into some other larger and consistent logic. Quantum theory shows that such a multiplicity of representation is not just imposed by external instrument but truly intrinsic to the quantum reality, even when it remains unobserved. It is such multiplicity of representation that allows us to think of what is possible in nature in objective terms (Omnes. 182).

In order to represent fairly the state of a system, we need to take into account the many components that revealed by quantum theory which otherwise are of minor significance in Boolean logic. The many component features in nature now becomes essential for speaking of the material world. We therefore need a logic that takes into consideration these many components in nature so that there is neither paradox nor internal contradiction. Quantum logic provides such logic that leads us close to reality.

The presence of many components in quantum systems makes us realize that classical physics is not our unique reference towards the knowledge of reality where logic can be applied and through which we can legitimately speak. On the contrary, it is the quantum world that has its own rules of description and reasoning from which those of classical world emanates (Omnes. 194). In the same lines Shimon says: «I see no reason to doubt Heisenberg's implicit claim that sense impression gathered in the subject/object mode are not the only road to knowledge; one can be linked to a central order, or come to know the inherent nature of the actual, in a moment of insight, a moment in which the subject/object mode is transcended (Shimon. 154).

4. BUB'S INTERPRETATION OF QUANTUM MECHANICS

Bub's interpretation is similar to the interpretation of Bohr who postulated the existence of a potential state and the actual state of the quantum system. According to Bub, «the difference between a classical world and a quantum world, is that the classical dynamics directly constraints the temporal evolution of what is *actual*, through the dynamical evolution of the *property state*, while the quantum dynamics directly constraints the temporal evolution of what is *possible* (and what is probable), through the dynamical evolution of the determinate sublattice defined by the quantum state and the preferable observable» (Bub. 120). So, according to Bub, *dynamical states* do not coincide with *property states*.

Bub's interpretation of quantum mechanics and the non Boolean relational structures, help us to realize that classical physics is not our unique reference towards the full knowledge of reality. We can neither legitimately speak of the totality of reality through classical concepts nor confidently rely on classical Boolean system of relations to track the movement of reality to a deeper level. In this sense, quantum mechanics reveals that reality cannot be fully described in terms of classical concepts such as space, time and causality. However, the quantum world has its own rules of description and reasoning which gives naissance to those of classical world. Quantum structural pattern, which underlies a non Boolean relational structure, is the fundamental nature of all reality whether observable or unobservable. Therefore quantum logic must be taken to be the basis of all knowledge since it is a mode of the relational interaction which is neither deterministic nor causal but can also accommodate determinism and causality in limiting cases.

5. TRANSCENDENCE

We saw that in Bohm's interpretation, though every particle has a precise position and a precise momentum at all times, yet we do not usually know what they are. These unknowable values to us are termed as «hidden variables». According to Bohm, this is an epistemic problem rather than ontic.

The way we understand the notion of Transcendence has been always influenced by the way we understand reality. According to the EPR paper, the ignorance of what is going on in nature has been interpreted in terms of hidden variable theorem. In the same way the unknowable or unreachable has been always been considered in the course of history to be something transcendent. However, Bohm's *dynamical states* and *non Boolean algebra* provide us with a way forward towards not only understanding this concept but also all other dynamic concepts.

5.1. Classical Transcendence

The present understanding of transcendence has been influenced by the way we understand the classical world. The properties of the classical system 'fit together' in a Boolean algebra which at the base of it has the binary opposition («true 1» and «false 0»). This binary opposition or duality is due to the *commutative*⁸ and *idempotent*⁹ properties of a classical reality.

⁸ The mathematical law stating that the value of an expression is independent of the order of combination of the numbers, symbols, or terms in the expression. The commutative law of addition applies if $x + y = y + x$. The commutative law of multiplication applies if $x \times y = y \times x$.

⁹ Idempotent describes the property of mathematical operations in which multiple applications of the operation do not change the result. A unary operation and binary operation are idempotent.

The concept of duality which has its roots in Boolean binary opposition is basically the one through which human beings observe and speak of reality. It is the concept through which we create the world of extremes; the world in which there are always two extremes of a spectrum. We perceive and understand the world as being divided into categories which are not only separate but also exclusive from one another. Throughout the history, duality has influenced the way we understand reality in many ways. Duality in Eastern religion is manifested in the opposition of the universe's basic principle of Yin and Yang. In Philosophy, dualism claims that neither the mind nor matter can be reduced to each other i.e. mind-body dualism. In philosophy of science dualism refers to the dichotomy between the «subject» (observer) and the «object» (the observed). In physics dualism refers to the fact that if two phenomena's mechanics are mutually exclusive, both are needed in order to describe the possible behavior e.g. wave-particle duality.

The basic meaning of transcendence was influenced by the Aristotelian philosophy in which *transcendence and immanence were considered as the dual concepts*. According to this duality what is transcendent is completely *outside of* and *beyond* the material world. A survey in various understanding of the concept of transcendence reveals that in general this concept means boundary or limit transcending. The boundaries may be natural, or due to ignorance or imposed artificially due to other limitations. The boundaries (whether natural or artificial) make some realities to be inaccessible to senses, knowledge, to experiments, to mind and even to some languages. In summary, that which is transcendent is inaccessible either in fact or in principle. This is the general understanding of transcendence from various review of literature.

The over emphasis of transcendence as being «*outside of*», «*separated from*», «*different from*» or «*beyond*» the physical reality is the consequence of arguments arising from the Aristotelian Boolean structure which implies causality. According to these arguments, transcendence is that which is outside, beyond and separated whether in *time*, *space* or in *essence*.

5.2. Quantum Transcendence

Quantum reality is much more complex and has more components than classical reality. Quantum reality is understood in terms of extension of probability distribution. Probability in quantum mechanics is understood in terms of *possibility structure for events*. It is these possibilities and probabilities that evolve dynamically in a quantum world. The properties of quantum system 'fit together' in a non Boolean algebra which at the base of it allows the range of values which are the superposition of «true 1» and «false 0». This intermediary values allow a gradual and inclusive transition between members of a set and it takes into consideration the different perspectives of the dynamic concept.

Moreover, the structure of fuzzy subsets and its non Boolean algebra allow us to think of the quantum reality and its dynamic concepts in terms of a sliding scale, approachable and inclusive, from one side to the other rather than the reality of exclusive binary extremes.

Transcendence in quantum mechanics is a dynamic concept which must be understood in terms of quantum dynamic state¹⁰. The quantum state is neither the subject of dynamism nor subject to dynamism, but rather is something constitutionally dynamic (Ground. 55). This dynamism is inscribed in the very reality of each thing and each thing is transcendently dynamic. Therefore, transcendence must be understood in terms of the range or extension of one's perception of reality. This becomes one's measurable quantity of perception *becoming* quality of understanding. In this sense transcendence in quantum mechanics cannot be detached from the reality since it refers to the path of dynamism of reality to its depth. This intrinsic dynamism brings about the movement from lower to higher forms of reality in the sense that reality realizes itself. As reality opens up itself dynamically, our knowledge of it also opens up dynamically. Transcendence is becoming more of reality and becoming more of our knowledge of it. It is a dynamic movement.

Transcendence in quantum mechanics is the process of uncovering deep treasures of the reality like archaeologists dig deep down the earth for the deeper truth. It is a deep movement into the reality. Ignacio Ellacuria rightly defines transcendence as: «that which transcends *in* reality and not that transcends away from reality; that which physically impels *to more* but not by taking out of; that which *pushes forward*, but at the same time retains» (Ellacuria. 254).

Transcendence in this sense is cumulative in the qualitative manner in the sense of gradual increasing towards the deeper reality. It is becoming more in size, intensity, power, etc. According to Ellacuria, transcendence in this sense is seen more in the relationship between *necessity* and *freedom* than between *absence* and *presence*. God is transcendent, among other reasons, not by being absent, but by being freely present – sometimes in one way and sometimes in another way, with different levels of intensity – in God's own self-giving will (Ellacuria. 255).

6. CONCLUSION

Mathematical model of quantum theory involves probability. The existence of probabilities in nature is what brings in the real fuzziness in nature which is expressed by the indeterminacy relations. Probability is what brings in dynamism in nature. This dynamism is inscribed in the very reality of each thing and each thing is transcendently dynamic. Moreover, non Boolean algebra with the concept of fuzzy subset has the broad utility since it provides us with meaningful representation of the dynamic concepts.

Non Boolean algebra allows us to look at the concept of transcendence in quantum mechanics as a dynamic concept which must be understood in terms of quantum dynamic reality. Quantum transcendence is therefore understood

¹⁰ State vector is the sole store of information from which we calculate the probabilities of the several possible outcomes of different types of measurement. Probability in nature is what brings in the real fuzziness in nature which is expressed by the indeterminacy relations.

in the qualitative manner; in terms of gradual sliding the scale towards the deeper reality. Transcendence is becoming more in size, intensity, power, etc.

If we refer this concept to God then God is transcendent means that He is revealing himself in various unlimited ways leading human beings to a deeper knowledge of his presence. God is transcendent not by being absent but by being present in different ways according to his will. St. Paul at the beginning of the letter to the Romans says «Since the creation of the world, God's invisible qualities – his eternal power and divine nature – have been clearly seen, being understood from what he has made» (Rom 1:20). This means the order and effectiveness of the processes of nature are part of God's presence and action in the world. This movement toward the deeper reality of God is what is behind the notion of transcendence.

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[Artículo aprobado para publicación en noviembre de 2009]